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PLAGUES OF THE HOUSE MOUSE IN SOUTH EASTERN AUSTRALIA

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ABSTRACT: Plagues of the house mouse (Mus musculus) occur at irregular intervals throughout the agricultural regions of south-eastern Australia. This paper discusses these phenomena in terms of their impact on agricultural production, previous attempts to reduce damage and levels of infestation, and associated environmental implications. Consideration is also given to the accurate prediction of mouse plagues and the control strategies which need to be in place if effective management is to become a reality.

INTRODUCTION

The house mouse (Mus musculus) was probably introduced to Australia with the first European settlers in the late 18th century. As with other continents, its distribution is virtually complete, ranging from the central deserts of Australia to the wetter coastal areas (Watts and Aslin 1981). Feral populations produce spectacular irruptions in desert, semi-arid and grain growing areas. It is in the cropping areas of south-eastern Australia that these irruptions or plagues cause major losses in agricultural production.

Because of their impact and associated sociological consequences, mouse plagues have been widely reported in the popular press. One such report was graphically presented in a Victorian newspaper during the 1917 plague: "At Lascelles 3 tons, reckoned to be approximately 200,000 mice, were caught in one night. Up to the end of June 1917, the recorded total weight caught came to 544 tons, thought to represent at least 32 million mice." A search of these reports and similar scientific literature (Saunders and Giles 1977) and more recent events suggest that there have been 10 major mouse plagues in south-eastern Australia since 1900. These plagues occur irregularly and are not cyclical as with other rodent species (Myers and Krebs 1974).

Attempts have been made with a variety of control strategies to reduce losses to standing crops and stored produce; however, these are mostly implemented when plagues have already approached their peak and consequently do little to reduce the overall impact.

Effective management of mouse plagues resulting in significant reductions in damage require an accurate predictive model, an increase in landholder awareness to the need for early initiation of management programs and suitable broadacre control techniques. Biological control is a potential alternative; however, the isolation of a species-specific pathogen seems remote in the immediate future.

DAMAGE POTENTIAL AND ASSESSMENT

In laboratory conditions adult mice have been recorded as consuming an average of 3.4 g of grain per day (Chitty and Southern 1954). The same authors go on to state that under normal conditions mice are also wasteful eaters, biting out small pieces of grain and often discarding the remainder. Thus the potential loss to crops and stored produce from mice is much higher than their actual food requirements.

During a study of a mouse plague in an irrigated sunflower crop in 1980 (Saunders and Robards 1983) the total population was estimated using a geometric frequency of capture model from capture, recapture data (Caughley 1977). This suggested a population density of 2716 mice/ha. Subsequent enclosure replications of this estimation technique indicated a correction factor in the order of 1.3, thus the true mouse density at the time of sampling would have been 3530/ha. Applying the conservative average grain consumption of 3.4 g per day, 3530 mice would reduce the crop yield by 12 kg per ha per day. The population estimate was made 7 weeks before the crop was harvested. Assuming that no control programs were implemented and that the population remained stable until harvest, the total grain loss during this period would be 588 kg/ha, which is equivalent to 29% of the normally expected yield.

In artificial enclosures mouse densities of 52,000 per ha have been produced (Lidicker 1976). Such numbers would not be unusual during mouse plagues in areas such as bulk grain storage facilities. The damage potential in these areas would also be compounded by contamination.

The damage caused by mouse plagues affects all facets of the rural community. These include losses to personal belongings, buildings and machinery, stored produce on farm, all crops (from sowing to harvest), livestock production through food contamination and disease transmission, and in bulk grain storage facilities. There are also many sociological effects with many people being driven out of their homes and tourists avoiding affected areas for the duration of a plague.

This wide range of damage makes the total economic loss attributable to mouse plagues difficult to quantify. Various estimates have been made for losses to standing crops and stored produce during the more recent plagues. In 1969-70 approximately 200,000 tons of wheat, oats, maize and sorghum valued at A$14 mill, were destroyed (Hopf et al. 1976). In one of the major irrigation areas during this plague, the average damage to all standing crops was estimated to be in the order of 15-25% (Ryan and Jones 1972). Surveys by the Victorian Government during the 1979-80 plague gave losses in that state at A $15-20 mill. (Anon. 1980). During the most recent plague in 1984, surveys conducted by government agencies in South

Australia, Victoria and New South Wales verified losses in excess of A$13 mill. However, this was known to be only a proportion of the overall figure (T. Redhead, pers. comm.).

PREDICTION OF MOUSE PLAGUES

The first major field study of the house mouse in Australia was conducted by Newsome (1969a, b). From this study, he concluded that a mouse population could irrupt only if good rain fell the previous winter and spring, the summer was hot enough to crack the soil and provide suitable burrowing conditions, and there was sufficient midsummer rain to keep the subsoil damp, to prevent desiccation of the mice and to provide an adequate feed supply.

The apparent anomaly that these conditions were met in many years in which there was no subsequent mouse plague led to an examination of the timing of plagues in relation to weather conditions in preceding seasons for the three major crop growing regions of south-eastern Australia (Saunders and Giles 1977). This study led to the hypothesis that mouse plagues follow a prolonged or severe drought over two or more winter-spring periods and then only after one or two good winter-spring periods. This was arrived at through examination of rainfall patterns derived from the cumulative deviation of monthly rainfall from the mean of that month for a number of meteorological stations in each area (Foley 1957). From this information, cumulative rainfall deficiency (residual mass) graphs were constructed to describe the actual rainfall patterns preceding each plague. Figure 1 gives the residual mass graph for the grain growing area of southern New South Wales prior to the last major mouse plague in 1984. The negative slope of this graph from August 1981 to March 1983 indicates a period of acute rainfall deficiency over two winter-spring periods followed by a period of above average rainfall in the subsequent winter-spring period. The predicted mouse plague occurred during the next crop growing season in 1984.

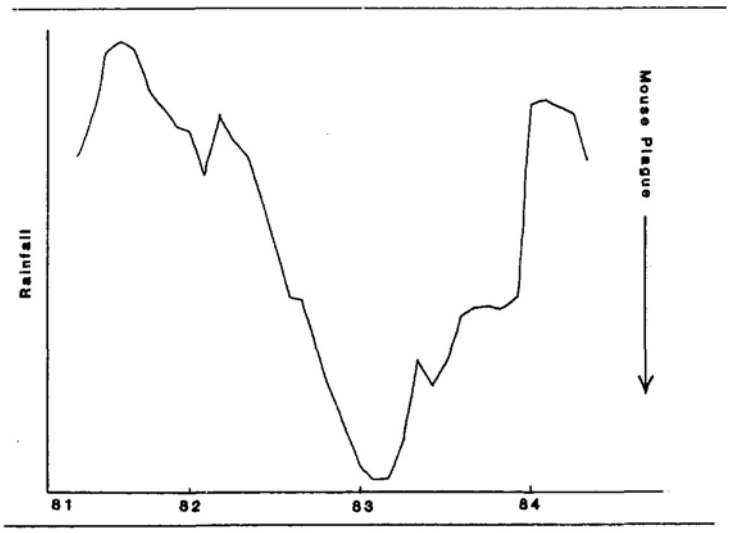

Figure 1. Rainfall residual mass graph.

The most recent field study of the house mouse is that of Redhead (1982). He concluded that the plague of 1980 was ultimately due to good autumn rains which fell nearly 2 years previously. These led to a sequence of qualitative changes in the mice and consequent changes in spacing behavior. Redhead proposed that these changes were due, penultimately, to the presence of high quality food for a long period, from spring to early winter in 1978.

Although the exact mechanisms which cause mouse plague are not yet clearly defined, it is apparent that they are weather-related. Furthermore, the models proposed above allow for the accurate prediction of mouse plagues well in advance of the actual event. The drought hypothesis, for example, positively predicted 8 of the last 10 major plagues. The accuracy of these models could be further enhanced by extensive monitoring of feral mouse populations.

MOUSE PLAGUE CONTROL

A multitude of control strategies have been employed during mouse plagues in attempts to reduce damage and levels of infestation. These have included the use of various trap designs, exclusion fences, ultrasonic devices, repellents and fumigation. The majority have involved baiting with poisons such as strychnine, organochlorine and organophosphorous compounds, arsenic, cyanide and anticoagulants. These techniques frequently produce spectacular results; however, the sheer numbers of mice which exist during a plague usually result in rapid replacement and consequently only minor reductions in the overall impact.

Rodent-proofing operations in domestic and bulk storage situations appear to offer the most benefit, although control programs in these areas prior to predicted plagues may reduce the source of many potential plague populations. If mouse plagues are to be effectively managed in the future, the most pressing need is for the development of broadacre control techniques which can be implemented well in advance of the predicted population peak. This would probably involve a combination of poisoning campaigns and habitat manipulation at a time when distribution and movement is limited and prior to the commencement of the breeding season. This approach is evident from various field studies of the house mouse (Pearson 1963, Berry 1968, Newsome 1969a, b; and Redhead 1982).

Unfortunately, there have been no serious attempts to control feral house mouse populations in pre-plague situations. During the height of the 1980 plague, evaluations were conducted of poisoning techniques in irrigated sunflower crops (Saunders 1983). Three types of poison (parathion, strychnine and bromadiolone) were tested with regard to efficacy. Bait was applied into crops from the air at a rate of 5 kg/ha total coverage. Census baiting estimated population reductions for these three poisons at 42, 63 and 90%, respectively. A further study of economic considerations from this work (Saunders and Robards 1983) indicated that the use of bromadiolone resulted in an estimated increase of 20% in the harvested yield.

This work offers encouragement for the potential of broadacre control by poisoning. Similarities existed between the mice living in the irrigated sunflower crops and what might be expected in pre-plague populations in that breeding was suppressed and movements limited. However, the success may not necessarily translate with major differences being the greater and more varied food supply available for much lower population densities in pre-plague mouse populations.

Habitat manipulation will also play an important role in mouse plague management, although at this stage the practices employed and the effectiveness of these are only the subject of speculation. The aims would be to reduce both the available food supply and vegetative cover in order to suppress the on-set of breeding, and to increase mortality rates in over-wintering populations. Redhead (1982) places particular importance on contours and channel banks used in irrigation farming. These provide ideal refuge for mice to subsequently invade maturing crops. He also emphasised the need to reduce grain spillage in harvested crops.

PESTICIDE CONTAMINATION IN ASSOCIATION WITH MOUSE PLAGUE CONTROL

Apart from the efficacy of broadacre mouse plague control, there are a number of environmental issues which remain unresolved. No chemical is registered under current Australian pesticide legislation for use in the field against the house mouse. In previous plagues this has resulted in the widespread and often indiscriminate use of illegal chemicals for poisoning campaigns brought about by landholder frustration at seeing crops and produce destroyed. The method of application varies from the laying of bait trails, aerial in-crop application, bait stations and, in extreme cases, the addition of poisons to irrigation water. The method of bait preparation also varies, frequently without regard to human safety.

The risk to non-target species, particularly birds of prey is of major concern. In an extreme instance during the 1980 plague, large numbers of birds were seen feeding on thousands of mice which had died as a result of baiting with endrin-treated wheat (Saunders and Cooper 1981). The bait was laid in a concentrated trail on open ground with mice dying only a short distance from the trail. It was also at a time when the diet of non-targets consisted almost entirely of mice.

Pesticide contamination of food crops is the other major problem. No chemical is considered safe to be registered for the baiting of mice either in growing crops or in areas which might be used for cropping. The registration of any chemical for this purpose in Australia requires the establishment of maximum residue limits (M.R.L.) in excess of one-twothousandths of the no-effect level in the most sensitive species tested. The high specificity of most rodenticides (which makes a rodent the most sensitive species) usually places this M.R.L. beyond the limits of detection for the analytical technique appropriate to the particular chemical. At present, this effectively eliminates the potential of broad-acre control with rodenticides.

The above problems suggest a number of advantages in organised broadacre control programs prior to development of the mouse plague. Firstly, bait application would need to be spread thinly on the ground in areas identified as winter refuge. Trail baiting would not be as effective because of the limited movements of mice. In areas where mouse numbers were concentrated, such as channel and contour banks, habitat manipulation by ploughing, burning or heavy grazing could be incorporated in the ongoing farm management program. This could be done over a period of time instead of in the urgency of a plague situation which usually results in concentrated baiting programs.

The presence of vegetative cover in areas where bait was applied would reduce exposure of non-target species to dead or dying mice. At the time of this bait application, reliance of most non-targets on mice as a food item would also be lower. Application of chemicals for mouse control in advance of sowing summer crops would increase the potential for natural breakdown in the soil. Finally, should a chemical ever satisfy registration requirements, bulk production of bait by the manufacturer would eliminate the risk of human contamination during mixing operations.

CONCLUSION

Before the effective management of mouse plagues in south-eastern Australia becomes a reality, a great deal of research remains to be conducted, particularly in the area of broadacre control and accurate long-range prediction. With suitable strategies in place, the rural community would have to be educated in the need to undertake these management programs in advance of a predicted plague. While these conclusions are simple to write, their realisation is made difficult by the lack of attention which is paid to these irregular phenomena in non-plague years. This problem was identified many years ago by Charles Elton (1942) when he said of mouse plagues in Australia "we have the crop destruction, and belated efforts at control of the mice; the natural end to the outbreak; the sigh of relief among politicians when the crisis has passed before any permanent study of the problem need be set up; and the recrudescence of the trouble in much the same form a few years afterwards."

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LITERATURE CITED

ANON. 1980. A report on the 1979/80 mouse plague. Vermin and Noxious Weeds Destruction Board, Victoria.

BERRY, R. J. 1968. The ecology of an island population of the house mouse. J. Anim. Ecol. 37:445-70.

CAUGHLEY, G. 1977. Analysis of vertebrate populations. John Wiley and Sons.

CHITTY, D., and H. N. SOUTHERN. 1954. Control of rats and mice. Vol. 3. House Mice. Oxford University Press.

ELTON, C. 1942. Mice, voles and lemmings, problems in population dynamics. Clarendon Press.

FOLEY, J. C. 1957. Droughts in Australia: a review of records from earliest years of settlement to 1955. Aust. Bur. Met. Bull. No. 43.

HOPF, H. S., G. E. MORLEY, and J. R. O. HUMPHRIES. 1976. Rodent damage to growing crops and to farm and village storage in tropical and subtropical regions. Centre for Overseas Pest Research and Tropical Products Institute, London.

LIDICKER, W. Z. 1976. Social behaviour and density regulation in house mice living in large enclosures. J. Anim. Ecol. 45:677-697.

MYERS, J. H., and C. J. KREBS. 1974. Population cycles in rodents. Sci. Amer. 230(6):38-46.

NEWSOME, A. E. 1969a. A population study of house mice permanently inhabiting a reed-bed in South Australia. J. Anim. Ecol. 38:361-77.

_____ . 1969b. A population study of house mice temporarily inhabiting a South Australian wheat-field. J. Anim. Ecol. 38:341-59.

PEARSON, O. P. 1963. History of two local outbreaks of feral house mice. Ecology 44:540-9.

REDHEAD, T. D. 1982. Reproduction, growth and population dynamics of house mice in irrigated and non-irrigated cereal farms in New South Wales. Ph.D. Thesis. Dept. Zool. Australian National University, Canberra.

RYAN, G. E., and E. L. JONES. 1972. A report on the mouse plague in the Murrumbidgee and Coleambally Irrigation Areas, 1970. New South Wales Dept. Agric, Sydney.

SAUNDERS, G. R., and J. R. GILES. 1977. A relationship between plagues of the house mouse and prolonged periods of dry weather in south-eastern Australia. Aust. Wildl. Res. 4:241-247.

_____, and K. COOPER. 1981. Pesticide contamination of birds in association with mouse plague control. EMU 82:227-229.

_____, and G. E. ROBARDS. 1983. Economic considerations of mouse plague control in irrigated sunflower crops. Crop Protection 2(2):153-158.

_____. 1983. Evaluation of mouse plague control techniques in irrigated sunflower crops. Crop Protection 2(4):437-445.

WATTS, C. H. S., and H. J. ASLIN. 1981. The rodents of Australia. Angus and Robertson.